

## CLAIMS

We claim:

- 1 1. A method of forming a high concentration borophosphosilicate glass layer on a  
2 substrate, the method comprising:  
3 providing a substrate in a chamber;  
4 providing a silicon source, a oxygen source, a boron source and a phosphorous  
5 source into the chamber to form a high concentration borophosphosilicate glass layer  
6 on the substrate; and  
7 reflowing the high concentration borophosphosilicate glass layer formed on the  
8 substrate.
- 1 2. The method of claim 1 further comprising cooling the substrate for a  
2 predetermined period of time following reflowing the high concentration  
3 borophosphosilicate glass layer formed on the substrate.
- 1 3. The method of claim 1 wherein the high concentration borophosphosilicate  
2 glass layer comprises about 2-7 weight percent boron and about 2-9 weight percent of  
3 phosphorous.
- 1 4. The method of claim 1 wherein a combined weight percent of boron and  
2 phosphorous present in the high concentration borophosphosilicate glass layer is about  
3 10-12 weight percent.
- 1 5. The method of claim 1 wherein providing the silicon, oxygen, boron and  
2 phosphorous sources into the chamber to form the high concentration  
3 borophosphosilicate glass layer on the substrate is performed at a deposition  
4 temperature in a range of approximately 300-600 °C.
- 1 6. The method of claim 1 wherein reflowing the high concentration  
2 borophosphosilicate glass layer is performed at a reflow temperature in a range of  
3 approximately 600-1050° C in an ambient selected from the group consisting of dry

4 ambient, steam ambient, water ambient and ambient formed by in-situ reaction of H<sub>2</sub>  
5 and O<sub>2</sub>.

1 7. The method of claim 1 wherein the silicon source is TEOS.

1 8. The method of claim 1 wherein the oxygen source is O<sub>3</sub>.

1 9. The method of claim 1 wherein the boron source comprises TEB.

1 10. The method of claim 1 wherein the phosphorous source comprises TEPO.

1 11. The method of claim 1 wherein the high concentration borophosphosilicate  
2 glass layer fills at least one trench contained in the substrate having an aspect ratio of  
3 about 7:1 to 10:1.

1 12. A method of forming an insulating layer on a substrate, the method comprising:  
2 providing a substrate in a chamber;  
3 providing a silicon source, a oxygen source, a boron source and a phosphorous  
4 source to chemical vapor deposit a high concentration borophosphosilicate glass layer  
5 on the substrate;  
6 forming a second insulating glass layer of undoped silicon glass over the high  
7 concentration borophosphosilicate glass layer; and  
8 reflowing the deposited high concentration borophosphosilicate glass layer on  
9 the substrate.

1 13. The method of claim 12 wherein the high concentration borophosphosilicate  
2 glass layer comprises about 2-7 weight percent boron and about 2-9 weight percent of  
3 phosphorous.

1 14. The method of claim 12 wherein a combined weight percent of boron and  
2 phosphorous present in the high concentration borophosphosilicate glass layer is about  
3 10-12 weight percent.

1 15. The method of claim 12 wherein reflowing the high concentration  
2 borophosphosilicate glass layer is performed at a reflow temperature in a range of

3 approximately 600-1050° C in an ambient selected from the group consisting of dry  
4 ambient, steam ambient, water ambient and ambient formed by in-situ reaction of H<sub>2</sub>  
5 and O<sub>2</sub>.

1 16. The method of claim 1 wherein the silicon source is TEOS flowing in the  
2 chamber at a rate of about 200-1000 milligrams per minute.

1 17. The method of claim 1 wherein the boron source is TEB flowing in the chamber  
2 at a rate of about 100-300 milligrams per minute.

1 18. The method of claim 1 wherein the phosphorous source is TEPO flowing in the  
2 chamber at a rate of about 10-150 milligrams per minute.

1 19. The method of claim 1 wherein the oxygen source is O<sub>3</sub> flowing in the chamber  
2 at a rate of about 2000-6000 standard cubic centimeters per minute.

1 20. The method of claim 1 wherein the high concentration borophosphosilicate  
2 glass layer is formed in the chamber at a rate in a range of approximately 2000 to 6000  
3 Å/min.

1 21. The method of claim 12 wherein the second insulating glass layer has a  
2 thickness in a range of approximately 100 to 200 Å.

1 22. A method of depositing an insulating layer on a substrate having at least one  
2 trench, the method comprising:  
3 chemical vapor depositing a high concentration borophosphosilicate glass layer  
4 over the substrate by providing TEOS, O<sub>3</sub>, TEB and TEPO into a chamber at a  
5 deposition temperature of about 300° C. to 600° C. and a sub-atmospheric pressure of  
6 about 60 to 750 torr, the high concentration borophosphosilicate glass layer comprising  
7 less than or equal to about 7.0 weight percent boron and less than or equal to about 9.0  
8 weight percent of phosphorous for a combined boron and phosphorous concentration of  
9 about 10-12 weight percent; and

10 reflowing the deposited high concentration borophosphosilicate glass layer at a  
11 reflow temperature in a range of approximately 600° C to 1050° C to fill the at least  
12 one trench in the substrate with the high concentration borophosphosilicate glass layer.

1 23. The method of claim 22 wherein the at least one trench has a high aspect ratio  
2 of about 4:1 to 10:1.

1 24. A substrate processing system comprising:  
2 a substrate holder located within a chamber;  
3 a gas delivery system to introduce a reactant gas mix into the chamber to  
4 deposit an insulating layer over the substrate;  
5 a pump coupled to a gas outlet to control the chamber pressure;  
6 a rapid thermal anneal system to reflow the layer deposited over the substrate;  
7 a controller to control the gas delivery system and the pump, the controller  
8 further to control the rapid thermal anneal system; and  
9 a memory coupled to the controller comprising a computer-readable medium  
10 having a computer-readable program embodied therein to direct operation of the  
11 substrate processing system, the computer-readable program comprising:  
12 instructions to control the gas delivery system to introduce a reactant gas  
13 mix including a silicon source gas, a boron source gas, a phosphorous source  
14 gas and a carrier gas into the chamber to deposit a high concentration  
15 borophosphosilicate glass layer over the substrate positioned on the substrate  
16 holder, the instructions further to control a temperature of the reflow to enable  
17 the deposited high concentration borophosphosilicate glass layer to fill a trench  
18 in the substrate.

1 25. The substrate processing system of claim 24 wherein the high concentration  
2 borophosphosilicate glass layer has a boron concentration in a range of approximately  
3 2-7 weight percent and a phosphorus concentration in a range of approximately 2-9  
4 weight percent for a combined boron and phosphorous concentration of about 10-12  
5 weight percent.

1 26. The substrate processing system of claim 24 wherein the reflow is performed at  
2 a reflow temperature in a range of approximately 600-1050° C in an ambient selected  
3 from the group consisting of dry ambient, steam ambient, water ambient and ambient  
4 formed by in-situ reaction of H<sub>2</sub> and O<sub>2</sub>.

1 27. The substrate processing system of claim 24 wherein the trench has a high  
2 aspect ratio of about 4:1 to 10:1.